

We claim:

1. A battery separator comprising:
a nonwoven flat sheet having a high temperature melt integrity;
a microporous membrane having low temperature shutdown properties; and
an adhesive bonding said nonwoven flat sheet to said microporous membrane and being adapted for swelling when contacted by an electrolyte.
2. The battery separator of claim 1 wherein said adhesive further comprises a swellable polymer.
3. The battery separator of claim 2 wherein said swellable polymer being selected from the group consisting of
polyvinylidene fluoride; polyurethane; polyethylene oxide;
polyacrylonitrile; polymethylacrylate; poly(methylmethacrylate);
polyacrylamide; polyvinyl acetate; polyvinylpyrrolidone;
polytetraethylene glycol diacrylate; copolymers of any the foregoing and combinations thereof.
4. The battery separator of claim 1 wherein the adhesive comprises a swellable polymer and a wetting agent.
5. The battery separator of claim 4 wherein said swellable polymer being selected from the group consisting of

polyvinylidene fluoride; polyurethane; polyethylene oxide; polyacrylonitrile; polymethylacrylate; poly(methylmethacrylate); polyacrylamide; polyvinyl acetate; polyvinylpyrrolidone; polytetraethylene glycol diacrylate; copolymers of any the foregoing and combinations thereof.

6. The battery separator of claim 4 wherein said wetting agent being selected from the group consisting of phthalate-based esters, cyclic carbonates, polymeric carbonates, and mixtures thereof.

7. The battery separator of claim 1 wherein said membrane being made from a thermoplastic polymer.

8. The battery separator of claim 7 wherein said thermoplastic polymer being selected from the group consisting of polystyrenes, polyvinyl chlorides, polyacrylics, polyacetals, polyamides, polycarbonates, polyesters, polyetherimides, polyimides, polyketones, polyphenylene ethers, polyphenylene sulfides, polysulfones.

9. The battery separator of claim 1 wherein said nonwoven flat sheet being made of polymers selected from the group consisting of thermoplastic polymers, cellulosic, and/or ceramics.

10. The battery separator of claim 1 wherein said nonwoven flat sheet further comprising a coating or surface treatment.

11. The battery separator of claim 10 wherein said coating or surface treatment being a ceramic material.

12. The battery separator of claim 11 wherein said ceramic material being selected from the group of alumina, silica, and zirconia compounds and combinations thereof.

13. A battery made with separator of claim 1.

14. Method of making separator comprising the steps of
providing a nonwoven flat sheet,
providing a microporous membrane,
providing an adhesive solution comprising a solvent and
a swellable polymer,
coating said sheet or said membrane or both said sheet
and membrane with the adhesive solution,
laminating together the nonwoven flat sheet and the
membrane, and
forming thereby the separator.

15. The method of claim 14 wherein the adhesive solution comprises a solvent, a swellable polymer, and a wetting agent.

16. The method of claim 14 wherein laminating further comprises applying temperature of about 120 - 135°C.

17. The method of claim 14 further comprising washing the laminated separator with a solvent.